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THE IODOFORM QUESTION; OR, THE VALUE OF IODOFORM IN THE TREATMENT OF DISEASED CONDITIONS OF THE TEETH.

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AMONG all the remedies which are or have been employed in the treatment of diseases of the human body, I doubt if one can be named which has been the subject of so many communications, or has so stubbornly resisted all attempts to work out a satisfactory theory of its action or to place a proper estimate upon its value, as iodoform. No more would it be easy to name a substance which for a time brought theory and practice into such apparently contradictory positions.

Iodoform is not so modern a remedy as it is usually thought to be, since it was discovered by Sérullas in 1822. Fifty years ago it was used in France and America quite extensively, both internally and externally, and appears to have remained in use up to the present. Radziejewski* writes: "Iodoform is a medicament much used in the United States of America, as well for internal, nervous, and constitutional diseases, stubborn neuralgias, particularly sciatica, cold fevers, inveterate syphilis, as externally in form of salves and plasters for painful burns, cancrus sores, syphilitic periostitis, etc."

In 1862 Rhigini† recommended it as disinfectant. It was not, however, till toward the close of the seventh decade of the present century that it attracted much notice in Germany, after Lazansky‡ and Moleschott§ had broken a lance in its behalf.

These communications appear to have given the signal for a general iodoform epidemic, which spread with great rapidity over Germany and Austria, and reached its culminating point in 1881-82. In these years there was probably not a surgeon, physician, or dentist in all

* *Centralblatt f. d. med. Wissensch.*, 1870, S. 544.

† *Journal de Brux.*, vol. xxxv, 1862, p. 62.

‡ "Das Iodoform und seine therapeutische Verwendung." *Vierteljahrsschrift für Dermatol. und Syph.*, 1875, S. 275.

§ "Ueber die Heilwirkung des Iodoforms." *Wiener med. Wochenschrift*, 1878, Nos. 24-26.

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Germany and Austria who had not made a trial of the wonderful remedy ; and if we were to recount all the afflictions for which iodoform was found to be beneficial, not many would remain unmentioned.

Tubercular affections, especially fungous processes, eczematous and lupous skin-diseases, fibroma molluscum, abscesses of the cornea and eczema of the eyelids, gonorrhea, bubo, syphilis, peritonitis, perioöphoritis, pelveo-peritonitis, metritis, perimetritis, parametritis, diseases of the mucous membrane of the mouth, nose, and throat, ozena, chronic catarrh, bronchitis, bronchorrhea, emphysema, diphtheria, otorrhea, carbuncle, furuncle, cold abscesses, phlegmon, pyothorax, purulent cystitis, gout, neuralgia, arthritis deformans, hydrocephalus acutus, anthrax, exsudations, wounds of every nature, struma, diseases of the teeth, pericementum, and jaw, and lastly, worms. These are some, but by no means all, the diseased conditions which were favorably acted upon by iodoform.

Dental surgeons also lost no time in making themselves acquainted with the popular medicament.

Schneider* seems to have been the first to publish the results of his observations. He found it useful in combination with arsenious acid for obviating the pain caused by the latter. Scheff† recommended it *in place of arsenic paste*, as an incomparably better remedy for preparing an exposed, not yet purulent, painful pulp for a temporary filling !

Tanzer used it with good success in all those cases where tincture of iodine had previously been employed, also in diseases of the pulp, and even for devitalizing it.

Skogsborg‡ treated pulpitis in its different stages, as well as acute and chronic periostitis (with or without suppuration), and also abscesses, etc., with his iodoform paste, with excellent results.

Wetzel§ used it in the form of a ten per cent. ethereal solution for exposed pulp ; furthermore, in combination with salicylic acid and morphin, for capping exposed and amputated pulps ; lastly, as iodoform cement paste for root-filling. Schmidt|| reports one hundred cases of chronic pulpitis treated according to Skogsborg's method with one hundred per cent. success, and over one hundred cases of acute pulpitis with ninety-one per cent. success.

Further references are, however, unnecessary, since the use of iodoform, particularly as a constituent of root-filling, became so prevalent that almost every dentist took part, in some way or other, in the discussion of this remedy.

Unhappily, it was almost always used in combination with other medicaments, such as carbolic acid, eucalyptus oil, oil of cinnamon, etc., so that it was impossible to determine what share in the success of the treatment was to be attributed to the iodoform.

The surgeons, however, were the most enthusiastic of all over the results which they obtained by the use of iodoform. They sometimes used it in enormous quantities. One hundred, one hundred and fifty, and even two hundred grams were poured into large abscesses, or into wounds produced by amputations or resections, and the most

* *Vierteljahrsschr. f. Zahnheilk.*, 1880. Heft iv, p. 333.

† *Ibid.*, 1881. Heft iv, p. 357.

‡ *Correspondenzbl. f. Zahnärzte*, 1882, p. 89.

§ *Ibid.*, p. 276.

|| *Deut. Monatsschr. f. Zahnheilk.*, 1884, p. 241.

celebrated surgeons of Germany and Austria reported excellent results, until the numerous cases of intoxication, in part fatal, which occurred on all sides very forcibly demonstrated that iodoform was by no means the harmless material it had been assumed to be, and that a certain amount of care should always be observed in its employment.

Various observations also established the fact that an idiosyncrasy for iodoform may exist, so that even small doses may be followed by symptoms of intoxication ; furthermore, that it possesses a cumulative action, in virtue of which the severest symptoms often appear after discontinuing its use.

Behring* disapproved of the use of iodoform on bleeding surfaces, for the reason that blood has the power to liberate iodine, which, as is well known, causes the intoxication.

These experiences had the effect of appreciably diminishing the enthusiasm for iodoform, and in particular of causing it to be employed with far greater care and discrimination than had previously been exercised. It, however, continued to be used very extensively and with good results, and the conclusion was gradually arrived at that iodoform, applied with a due amount of caution, is, for certain conditions, an excellent though not infallible antiseptic.

Great therefore was the astonishment caused by a publication by Heyer and Rovsing,† showing, as the result of experiments, that iodoform not only possesses no antiseptic action, but, on the contrary, itself often harbors pathogenic micro-organisms, which may be transferred to the wound in the application of the remedy.

This publication was received with a storm of indignation. It was claimed that hundreds of thousands of cases in practice had sufficiently proved the value of iodoform, and that the medical world was not to be frightened out of using a tried and approved remedy on account of a few mycological experiments, which might be correct for pure cultures, but which did not admit of drawing conclusions for the living animal body.

Nevertheless, a repetition of the experiments of Heyer and Rovsing, which was undertaken by bacteriologists on all sides, showed that their results were in the main correct, and led to the establishment of the conclusion that iodoform-powder, strewed on plates of gelatin or agar-agar, usually exerts but an insignificant retarding action upon the growth of bacteria, and often none at all, and that it has only in exceptional cases, as in that of cholera bacilli, a devitalizing action.

On the other hand, it was justly pointed out that iodoform, like every other remedy, must be in solution before it can exert its action : *Corpora non agunt nisi fluida*, and while no solution takes place on the culture-plates, it is brought about in the animal body, and particularly on wound surfaces, by the fat, the secretions of the wound, nascent oxygen and hydrogen, by bacterial products, etc.

But iodoform in solution is very unstable, easily becomes decomposed, and gradually gives off iodine, which exerts its peculiar antiseptic action. That iodine is actually set free is amply proved by

* "Ueber Iodoform und Iodoformwirkung." *Deut. med. Wochenschr.*, 1882 No. 11.

† *Fortschritte der Medicin*, 1887, No. 2.

its appearance in the fluids of the body, and by the many cases of iodine intoxication following the use of iodoform. De Ruyter* furthermore made the important discovery that the ptomaines have the power to set iodine free, while Behring† showed that the pus-exciting ptomaines, especially pentamethylenediamine (cadaverin), when mixed with iodoform, lose their power to produce suppuration.

It would, however, lead us too far should I attempt to consider even a small proportion of the communications that appeared on this subject. According to the views adopted at present, theory and practice seem to agree pretty nearly that a wound-surface, especially a secreting one, is favorably influenced by iodoform, not so much because of its antiseptic action as because of its power to take up the secretions of the wound as well as the products of decomposition and bacterial poisons (ptomaines, toxalbumins), and to act upon them in such a way that they lose their toxic properties.

My object in undertaking a series of experiments on the subject of iodoform was to test it from a dental point of view, and, if possible, thereby to render some assistance in the attempt to answer the question whether and under what conditions iodoform is a valuable remedy in the treatment of diseases of the teeth and surrounding tissues.

The antiseptic action of iodoform was tested: 1. In powder on pure cultures. 2. In connection with putrid matter. 3. In connection with putrid matter under the action of living animal cells. 4. By comparative experiments on the animal body.

1. The action of iodoform upon pure cultures of various bacteria from the human mouth and from gangrenous tooth-pulps was tested by strewing the powder upon certain portions of the cultures, while the other parts were left free. In no case was I able to detect any difference in the growth of the bacteria in different parts of the culture; they grew in the immediate proximity of the iodoform as well as at the points most remote from it. Only among a few cases where the plates were kept for twenty-four hours at a temperature below that at which the bacteria grew (in order to give the iodoform ample time to develop its action), before putting them into the incubator, one showed a very slight retardation in the development where large quantities of iodoform had been used.

2. In order to test the accuracy of the statement that iodoform in connection with putrid matter exerts a retarding influence upon the development of bacteria, I proceeded in the following manner:

A number of pulps or pieces of pulps from calves' teeth were moistened with water, and kept at blood temperature until they had developed a strong putrid smell. They were then imbedded in iodoform and placed in the incubator. After three days, one of them was taken out and put upon a plate of agar, in the expectation that it would be found completely sterile. I was consequently somewhat surprised to find, after twenty-four hours, that it was surrounded by a broad rim of bacteria. The experiment was repeated after five, seven, eleven, eighteen, and twenty-six days, four months, seven months, and lastly after eleven months and thirteen days, always with the same result (Fig. 1). During the last seven months the

* *Deut. med. Wochenschr.*, 1887, No. 18.

† *Ibid.*, No. 20.

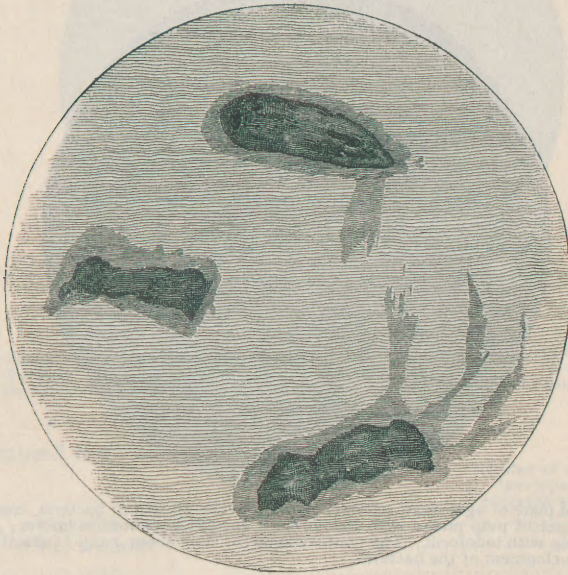
pulp had been kept at room temperature. In this case we see that a contact of iodoform with putrid matter during the space of almost a year had not sufficed to devitalize the bacteria present.

In like manner a putrid fluid was shaken up with iodoform-powder and kept in the incubator. After twenty-six days, living bacteria were still found in it. The antiseptic action was consequently practically equal to nothing in these cases.

Also putrid pulps from human teeth, rolled in iodoform and placed at once, or after a few hours, upon plates of nutritive agar-agar, were found surrounded by a proliferous growth of bacteria the next day.

A method of experimentation which I have recently adopted has furnished some results worth noting. A very putrid, foul-smelling

FIG. 1.



An agar-agar plate with three pulps (from calves' teeth), which had laid for over eleven months in iodoform. All three are enveloped in a vigorous growth of bacteria.

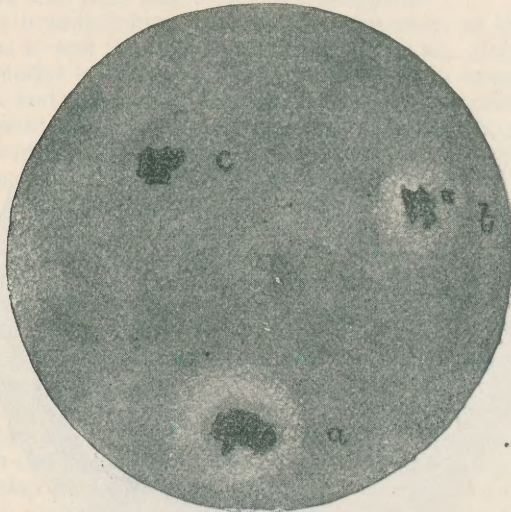
pulp was divided into about equal portions, one of these thoroughly incorporated with iodoform by working them together with a spatula, and placed upon a freshly poured infected plate of agar-agar. At the same time, the other portion without iodoform, and also a piece of a *healthy pulp with iodoform*, were placed upon the plate, to serve as checks or control experiments. One of these plates, as it appeared after it had been for two days in the incubator, is shown in Fig. 2. The transparent zone about the pieces *a* and *b* indicates a slight antiseptic action. It will be seen that the healthy pulp-tissue with iodoform (*c*) has exerted no retarding influence whatever, whereas the piece of putrid tissue incorporated with iodoform (*a*) shows an appreciable retarding influence. It is but slightly greater, however, than

is shown by *b*, with which no iodoform was used.* Nor is it always as apparent as in the case illustrated, sometimes being entirely wanting. If we compare its action with that of sublimate (Fig. 3, *a*), we see how very slight it is.

The results of a number of experiments have led to the establishment of the fact that pieces of freshly extracted putrid pulps, thoroughly incorporated with iodoform, sometimes acquire the power to very slightly arrest the growth of bacteria in their immediate neighborhood.

We must not, moreover, lose sight of the results of Behring's† researches, who found that iodine is liberated from iodoform only under the action of light and oxygen. In vascularized animal tissues

FIG. 2.



An inoculated plate of agar-agar, strongly clouded by the growth of bacteria, containing : *a*, a portion of a putrid pulp mixed with iodoform ; *b*, the same without iodoform ; *c*, a portion of a healthy pulp with iodoform. The semi-transparent zone about *a* and *b* indicates a retardation in the development of the bacteria.

the living cells may take the place of light, while the oxygen is furnished by the oxyhæmoglobin of the blood.

In the root-canal, however, these two factors are wanting, and it is possible; therefore, that even the very slight antiseptic action which iodoform in connection with putrid matter appears to exert on pure cultures of bacteria outside of the human body may not develop in the canals of the roots of teeth.

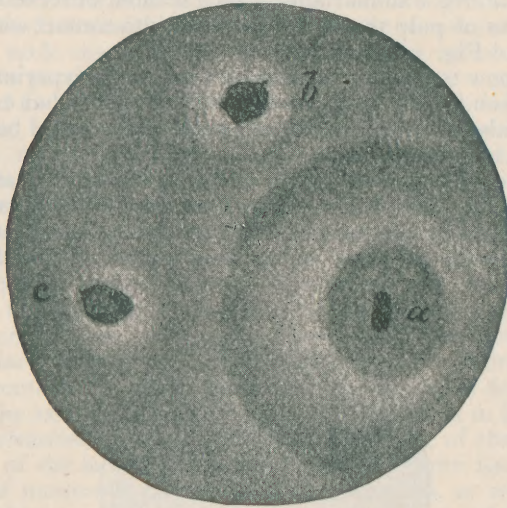
3. *The antiseptic action of iodoform in connection with putrid matter in the animal body* was tested in the following manner :

* I have frequently observed that pieces of putrid tooth-pulps dropped upon plates of pure cultures retard the development of the bacteria of the pure culture in their immediate neighborhood. This, however, is not to be wondered at, since we know that the poisons produced by one kind of bacterium may be fatal to another kind.

† *Deutsche med. Wochenschrift*, 1882, S. 278.

A purulent or putrid pulp was cut into small pieces, and half of them incorporated with iodoform. These pieces, both those with and those without iodoform, were placed in skin-pockets at the root of the tails of white mice. After two to three days I took them out again, together with any pus which might be present, rubbed them up in melted agar, which was then poured in the customary manner, and placed in the incubator.

FIG. 3.



An inoculated plate of agar-agar containing: *a*, a portion of a putrid pulp mixed with sublimate; *b*, the same with iodoform; *c*, the same without any antiseptic. Note the extensive action of the sublimate. The dark zones about *a* are due to a precipitate caused by the sublimate.

I obtained the following results :

| | | Number of colonies which developed from the contents of the pockets. |
|--------|---------------------------------|--|
| 1 pair | { <i>a</i> , with iodoform..... | 3400 |
| | { <i>b</i> , without "..... | 3600 |
| 2 pair | { <i>a</i> , with "..... | 4 |
| | { <i>b</i> , without "..... | 6470 |
| 3 pair | { <i>a</i> , with "..... | 47250 |
| | { <i>b</i> , without "..... | innumerable |
| 4 pair | { <i>a</i> , with "..... | 45 |
| | { <i>b</i> , without "..... | innumerable |
| 5 pair | { <i>a</i> , with "..... | innumerable |
| | { <i>b</i> , without "..... | innumerable |
| 6 pair | { <i>a</i> , with "..... | innumerable |
| | { <i>b</i> , without "..... | innumerable |
| 7 pair | { <i>a</i> , with "..... | 11700 |
| | { <i>b</i> , without "..... | innumerable |

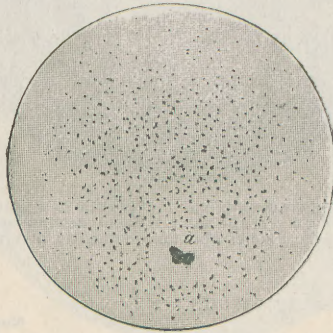
In most of the cases we see a considerable difference in the number of colonies in favor of those where iodoform was used,—a fact which, as we shall see below, is to be explained not so much by any antiseptic action of the iodoform or the iodine, as, according to my opin-

ion, by the circumstance that in the pockets treated with iodoform the bacteria had much less nourishment, and consequently much less favorable conditions of development than in those where no iodoform was applied. We occasionally observe on the culture-plates that the pieces of pulp to which iodoform still adhered were sometimes surrounded by a transparent zone two to three mm. broad (Fig. 4), which may be regarded as due to an extremely slight antiseptic action, although one must be cautious in drawing such a conclusion, since, as we have seen above, a similar appearance is often observed in connection with pieces of pulp that have not come into contact with iodoform (Fig. 2, *b*, and Fig. 3, *c*).

4. I have now to give the results of a series of experiments which were undertaken for the purpose of determining to what extent infections made with pieces of gangrenous tooth-pulps could be influenced by the use of iodoform.

The method of experimentation was practically the same as that described under 3, with the exception that the pathological instead of the bacteriological symptoms were studied twenty-four hours after the infection of mice by pieces of gangrenous pulps. I found, as a rule,

FIG. 4.



An agar-agar plate inoculated with the contents of an iodoformized skin-pocket. At *a* a small piece of pulp-tissue impregnated with iodoform has prevented the development of colonies in its immediate vicinity.

that the cases where the pieces had been incorporated with iodoform showed more swelling than those where none was used. This result is not, however, to be attributed to a stronger inflammatory process in the former case, since a closer examination shows it to be due to the fact that the iodoform takes up the secretions of the wound, becoming more or less distended or puffed thereby. The skin around the wound has usually a good appearance, or is slightly reddened, very seldom discolored; while that of the control-mouse very frequently presents a bluish or bluish-black color.

On opening the pockets at the end of the second or third day, we find them, in cases where iodoform has been used, sometimes quite dry and rapidly healing; in other cases containing a small quantity of stringy, thick pus, very rarely showing any signs of decomposition. In case of the control-mice the quantity of pus will be found greater on an average, and it is very often thin, discolored, and has a putrid smell. The tissue at the bottom of the pocket, in what may be called

severe cases, is also infiltrated with pus and in a process of dissolution.

The difference was not always as marked as in the cases just described; in some cases it was but slight. But the experiments so often turned out in favor of the iodoform, especially where very putrid material had been used, that its good effects could not be mistaken. I should not omit to mention that fifteen to twenty per cent. of the mice operated upon died from iodoform intoxication, notwithstanding the fact that scarcely more than six to eight milligrams (or about one two-thousandth of the weight of the mouse) of the powder was used in each case. The apparent antiseptic action of the iodoform, which is particularly noticeable in experiments 2, 3, and 4, must be accounted for, I think, in the following manner: Iodoform restricts the formation of pus by a paralysis of the protoplasm of the leucocytes (Binz), or, more probably, by a destruction of the poisonous chemical substances in the putrid pulp-tissue (de Ruyter, Behring). Furthermore, the iodoform, in absorbing at least a part of the secretions of the wound, exerts a direct desiccating action. The iodoformed pocket therefore offers an unfavorable culture-medium, principally on account of its lack of nourishment for bacteria.

This view is supported by the observation that wherever there was much moisture or pus present a corresponding development of bacteria took place, notwithstanding the presence of iodoform.

I must, therefore, for this reason, take the liberty to doubt the correctness of the assertion that the action of iodoform is to be accounted for by the *attraction* of phagocytes, which dispose of the bacteria, to say nothing of the fact that this view does not quite harmonize with the results of numerous bacteriological researches, or with the experience of celebrated clinicians, who have testified that iodoform *restricts* the emigration of the leucocytes.

In summing up the results of my experiments, I can only state that iodoform, either alone or in connection with putrid pulp-tissue, or in the same connection under the influence of the living animal cells, has been found to exert directly but a very insignificant retarding action upon the development of bacteria, and in no case a devitalizing action; that it nevertheless exerts a very beneficial action upon wounds to which it can be freely applied, and *indirectly* a retarding action upon the development of bacteria in that it deprives them of the nourishment necessary to their proliferation.

We may draw the following conclusions from the results of these experiments for the use of iodoform in dentistry:

1. It is not to be recommended for putrid conditions of the root-canal, as its antiseptic action in this case amounts to about nothing, and we have a large number of much more serviceable remedies at our command.

2. As root-filling, also, iodoform has no advantage over any one other indifferent insoluble powder; on the contrary, it has the great disadvantage of its disagreeable odor. Only in the case where a large open apical foramen is present, it may be advisable to incorporate a little finely pulverized iodoform into the cement with which such canals should be filled, on account of its beneficial action upon the tissue about the end of the root.

3. In the treatment of exposed pulps, iodoform can only be

expected to exert an influence if it can be applied to a comparatively large surface. Where, on the contrary, the pulp is only exposed at one point or in a very slight degree, and particularly where the opening is filled up with *débris* and pus, it will be next to useless to apply iodoform.

4. The application of iodoform in the treatment of periostitis, abscesses, and fistulæ also seems to me to be of little purpose. The remedy exerts its influence but slowly, even under the most favorable conditions, and must be applied in comparatively large quantities. It therefore seems very improbable that it should be able to act through the apical foramen in a measure sufficient to produce a beneficial effect on a periostitis or an abscess.

If abscesses and the like have been observed to disappear after treatment with iodoform, the result is principally due to the mechanical cleansing of the root-canal (*i.e.*, removal of the cause) which preceded the use of the remedy. It may also be partly due to the action of various other ingredients of the paste, but certainly least of all due to the iodoform itself.

In large wounds in the oral cavity, where the use of an antiseptic is indicated, iodoform takes a prominent position on account of its comparatively non-poisonous nature.

